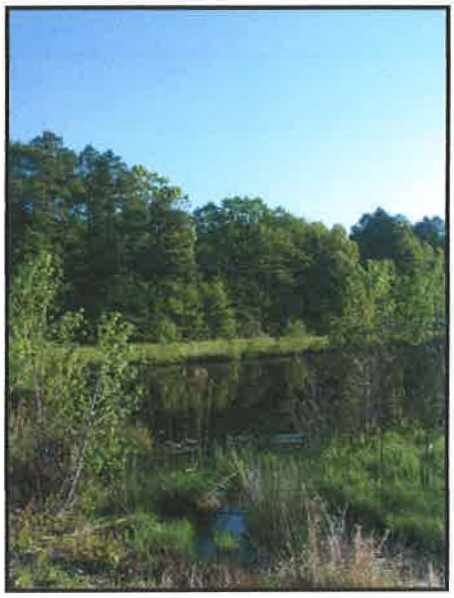
# BIOLOGICAL EVALUATION OF GYPSY MOTH

at

Blackwater National Wildlife Refuge
-Part of the
Chesapeake Marshlands National Wildlife Refuge Complex

2014



Prepared by

Karen D. Felton
Entomologist

USDA Forest Service
Forest Health Protection
Morgantown, WV 26505

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**Abstract**

In June 2014, the Blackwater National Wildlife Refuge (BNWR), which is part of the Chesapeake Marshland National Wildlife Refuge Complex (CMNWRC) in Maryland, experienced gypsy moth defoliation on approximately 256 acres in the Kentucky Swamp area of the refuge. In August 2014, USDA Forest Service personnel conducted a gypsy moth egg mass survey at BNWR to assess the potential for defoliation and the need for treatment in 2015. Current populations are sufficient to cause noticeable defoliation on approximately 500 acres. Treatment is recommended in 2015 in order to protect the endangered Delmarva fox squirrel habitat from tree defoliation, prevent a reduction in oak mast production, provide nuisance abatement in the Key Wallace Hiking Trail area, and prevent possible oak tree mortality.

**History**

The USDA Forest Service, Morgantown Field Office (MFO) has had a long relationship with BNWR over the last 22 years. There have been 10 gypsy moth spray projects from 1993 – 2003. A total of 7, 736 acres were treated with *Bacillus thuringienis* variety *kurstaki* (*Btk*) and a total of 5,019 acres were treated with Gypchek during that time. Gypsy moth activity has been relatively quiet since 2003.

A report written by Rod Whiteman and Brad Onken, "Protecting Delmarva Fox Squirrel Habitat From Gypsy Moth and Southern Pine Beetle, Blackwater National Wildlife Refuge, 1994", assigned forest stands at BNWR with a gypsy moth hazard rating. When gypsy moth infestations build up, this hazard rating provides focus on where to conduct gypsy moth surveys.

In June 2014, the MFO was contacted by the Maryland Department of Agriculture about gypsy moth defoliation that was observed in stands 5 and 6 on the BNWR property (Figure 1). We also utilized the US Forest Service, Forest Health Technology Enterprise Team (FHTET) Forest Disturbance Monitor (FDM) website (http://foresthealth.fs.usda.gov/portal/Flex/FDM?dL=0 ) to identify any other areas of forest canopy disturbance that were occurring elsewhere on the Refuge. To detect forest canopy changes, the FDM uses moderate resolution imaging spectroradiometer (MODIS) data from orbiting satellites, it normalizes the difference vegetation index (NDVI) data and compares it with the 3-Year Real Time Forest Disturbance (RTFD) data (a 3 year baseline of greenness), to produce a digital change detection product. In addition to the area in stands 5 and 6, there were several other areas of canopy disturbance observed on the FDM within the BNWR boundary. However, these areas did not prove to be defoliation but rather false positives. A total of 256 acres of scattered moderate to heavy gypsy moth-caused oak defoliation was mapped at BNWR in 2014 (Figure 2). A large number of vertically and a few v-shaped hanging gypsy moth cadavers were observed on the boles of the trees. This is indicative of the fungal pathogen of gypsy moth, *Entomophaga maimaiga* , and the gypsy moth nucleopolyhedral virus (NPV), respectively (Figures 3-4). The NPV does not kill as quickly as the fungus, so its affects are usually masked by the presence of the fungus. Trees that experienced heavy defoliation, also had some level of re-foliation by the end of the summer. Within the last year a portion of stand 6, received an improvement cut to promote oak growth and mast production for Delmarva Fox Squirrel habitat and experienced heavy defoliation as well (Figure 5-6).

## Methods

Gypsy moth survey plots were randomly selected based upon available host trees (oak species) in and adjacent to areas that experienced gypsy moth defoliation in 2014. The assigned gypsy moth hazard rating was also taken into account when selecting adjacent stands to survey.

At each sample point, a 1/40$^{th}$ acre fixed radius plot was established. An inspection of all egg masses within reach was used to estimate the portion of new (2014) to old egg masses at each plot (percent new egg masses). This percentage was applied to the tally of all egg masses observed above the reachable surface. The plots consisted of a tally of all new egg masses observed on overstory trees, understory vegetation, ground litter and duff. The total number of new egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. Small egg masses ( <20 mm in length) are indicative of a declining population, while large egg masses ( >30 mm in length) of an increasing population (Liebhold et al. 1994).

Defoliation predictions for 2015 were based on the egg mass density, threshold, egg mass length, population trends, and species composition (Liebhold et al. 1994, Leibhold et al. 1993; Table 1). Intervention thresholds were stablished on resource management objectives and nuisance abatement, and the prevention of defoliation.

**Table 1.** 2014 Gypsy moth egg mass density thresholds for resource management objectives on the Blackwater National Wildlife Refuge, MD.

| Threshold (egg masses/acres) | Predicted Defoliation | Objectives |
|---|---|---|
| 250 | < 30[1] % | Nuisance Abatement |
| 251-500 | 30 - 40 % (Light) | Prevent Noticeable Defoliation |
| 501-1000 | 41 - 60 % (Moderate) | Prevent Growth Loss |
| >1000 | > 60 % (Heavy) | Prevent Mortality |

[1] None or background level of defoliation.

## Results

The locations of the survey plots are shown in Figure 7. The summarized results of the survey are presented in Table 2.

Egg mass densities per acre throughout the surveyed areas at BNWR ranged from 0-920 and averaged 216 egg masses per acre. Overall average egg mass lengths ranged from 18-28 mm and averaged 24 mm. Egg masses were found in stands 4, 5, 6, and 7. Populations within these stands are viable, ranging from 0-920 and averaging over 300 egg masses per acre in 3 out of the 4 stands, and high enough to cause noticeable defoliation within portions of the stands. No egg masses were found in stands 1 and 3.

**Table 2.** 2014 Gypsy moth egg mass survey results, predicted defoliation, and special concerns for surveyed stands at the Blackwater National Wildlife Refuge, MD.

| Stand Number | Gypsy Moth Hazard Rating | Average Egg Masses per Acre | 2015 Predicted Defoliation (%) | Special concerns regarding 2015 gypsy moth defoliation |
|---|---|---|---|---|
| 1 | Moderate | 0 | 0 | No defoliation predicted / no concerns in 2015 |
| 3 | Moderate | 0 | 0 | No defoliation predicted / no concerns in 2015 |
| 4 | High | 340 | 30-40 | Moderate to heavy defoliation in 2014, adjacent to stand 6 |
| 5 | Moderate | 32 | < 30 | Adjacent to stand 6 and defoliation in 2014, Key Wallace Hiking Trail and Demonstration Forest |
| 6 | Moderate | 320 | 30-40 | Moderate to heavy defoliation in 2014, oak improvement cut, Key Wallace Hiking and Demonstration Forest |
| 7 | Moderate | 354 | 30-40 | Moderate to heavy defoliation in 2014, adjacent to stand 6, Key Wallace Hiking Trail and Demonstration Forest |

**Discussion**

The survey results indicate that noticeable defoliation is likely to occur on approximately 500 acres in stands 4-7. Since egg mass densities and host type are not evenly distributed, actual defoliation will vary somewhat from tree to tree throughout stands 4-7. Even though stand 5 has low gypsy moth egg masses counts, it could still experience some noticeable defoliation and stand 5 does contain the Key Wallace Hiking Trail and Demonstration Forest, therefor it has been included in the 500 acres in order to meet the objective of nuisance abatement (Figure 8).

At BWNR the average egg mass length is 24 mm and both the fungus and virus were observed in these stands in 2014 and it is possible that either could cause a general collapse next year if wet weather conditions occur in the spring of 2015. However, a population collapse is not likely to occur prior to a defoliation event in 2015.

Since defoliation reduces the trees ability for future photosynthesis and re-foliation events causes the tree to expend carbohydrate reserves, these factors that must be considered when deciding whether intervention is necessary or warranted. Other factors that need to be considered are the condition of the trees at the time of defoliation (i.e. stand stocking, age and amount of susceptible species present). Studies have shown (Gottschalk 1989), that reduced growth, mast abortion, branch dieback or in some cases tree mortality, has been observed following a single year of heavy defoliation. Should a subsequent period of drought or other stressors occur during a defoliation event or even after, the potential impact on individual trees may be compounded

**Management Options**

For 2015, two management options have been evaluated for managing gypsy moth populations at BNWR. The intervention option is offered based upon the following two treatment objectives: 1) for nuisance abatement of gypsy moth population in high value recreation areas and 2) protect host tree

foliage to prevent branch dieback, mast production failure, and tree mortality. Each option is discussed below.

*No Action Option*

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the fungal pathogen, *E. maimaiga.* In areas with defoliating levels of gypsy moth populations (greater than 500 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with information at hand, it is unlikely that a collapse will occur prior to defoliation.

Should this option be selected, it is likely that noticeable defoliation will occur in stands 4-7 at BWNR in 2015. There is also the potential for population densities to increase in infested stands and expand to currently un-infested areas in 2015.

*Microbial Insecticide Option*

***Btk*:** The second option is to use microbial insecticides to manage gypsy moth populations. Only one biological insecticide is currently registered and commercially available for gypsy moth control. It is the microbial insecticide, *Bacillus thuringiensis* variety *kurstaki (Btk). Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis, which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* has been shown to impact other non-target caterpillars that are exposed to the treatment when actively feeding. *Btk* is persistent on foliage for about 7-10 days.

*Btk* is not specific and may reduce populations of short term non-target lepidoptera larvae that may be feeding at the same time as gypsy moth caterpillars. Several factors must be taken into account when using *Btk* such as: 1) the potential for short term non-target extirpation in the proposed spray area; 2) the life stage present and any deferential susceptibility to *Btk* that may exist between species of non-target lepidoptera; 3) the size and uniqueness of the area beginning proposed for treatment. Since much of this site-specific data regarding non-target lepidoptera may not be known for many areas, the potential benefits must be weighed against any potential impacts to non-targets.

*Btk* formulations are available as a flowable concentrate. The normal application rates range from 24-38 Cabbage Looper Units (CLU's) per acre in a single application for a total volume of ½ to ¾ gallon per acre. Double applications may be used in areas of healthy building populations where the egg mass densities may exceed 3,000 egg masses per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application. Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather

(rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product (CLU's).

**Gypchek:** A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it can be difficult to project treatment efficacy with less than optimal conditions following treatment. Most often foliage protection is achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is $2 \times 10^{11}$ occlusion bodies (OB's) per acre applied in two applications, or a single application at $4 \times 10^{11}$ OB's. When supplies are limited, priority is given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There will be an adequate supply of Gypchek available for use at BNWR in 2015.

## Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1 - No action

Alternative 2 - One aerial application of *Btk* at the rate of 24-38 CLUs in a total mix of ½ to ¾ gallon per acre.

Alternative 4 - One aerial application of Gypchek at the rate of $4 \times 10^{11}$ OB's in a total mix of 1 gallon per acre.

Alternative 5 - Two aerial applications of Gypchek at the rate of $2 \times 10^{11}$ OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

**Recommendations**

As previously stated, gypsy moth populations are sufficient to cause noticeable defoliation in stands 4-7 at BNWR. Most of the time, this level of defoliation would not warrant treatment; however, the Refuge

has invested in a stand improvement cut to promote oak mast production for the habitat of the endangered Delmarva fox squirrel in stand 6, this area received moderate to heavy defoliation in 2014, and the area is also the location of the Key Wallace Hiking Trail and Demonstration Forest. Taking all of this into account, our recommendation is Alternative 4, a single aerial application of Gypchek to stands 4-7, totaling 500 acres; in order to help protect tree foliage, prevent possible mast production failure, provide nuisance abatement on the Key Wallace Hiking Trail and prevent possible tree mortality.

The recommendation is further supported by the fact that the BNWR insecticide of choice is Gypchek. A single application of Gypchek will likely provide adequate foliage protection and reduce the existing population below the treatment threshold, and cost about one half that of a double application of Gypchek. Gypchek is host specific which minimizes the risk to other non-target organisms including lepidopteran caterpillars.

**References**

Gottschalk, K.W. 1989. Gypsy moth impacts on mast production, *In:* McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 42-50.

Liebhold, A.M., K. Thorpe, J. Ghent, and D.B. Lyons. 1994. Gypsy Moth Egg Mass Sampling for a Decision-Making: A Users' Guide. USDA Forest Service, Technical Bulletin NA-TP-04-94 pp. 21.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Figure 1. Gypsy moth caterpillar eating oak leaves at BNWR, June 2014.

Figure 2. Map showing location of confirmed gypsy moth defoliation in June 2014 at Black Water Wildlife Refuge in Maryland. Source: *US Forest Service, Forest Health Technology Enterprise Team (FHTET) Forest Disturbance Monitor (FDM) website, June 2014.*

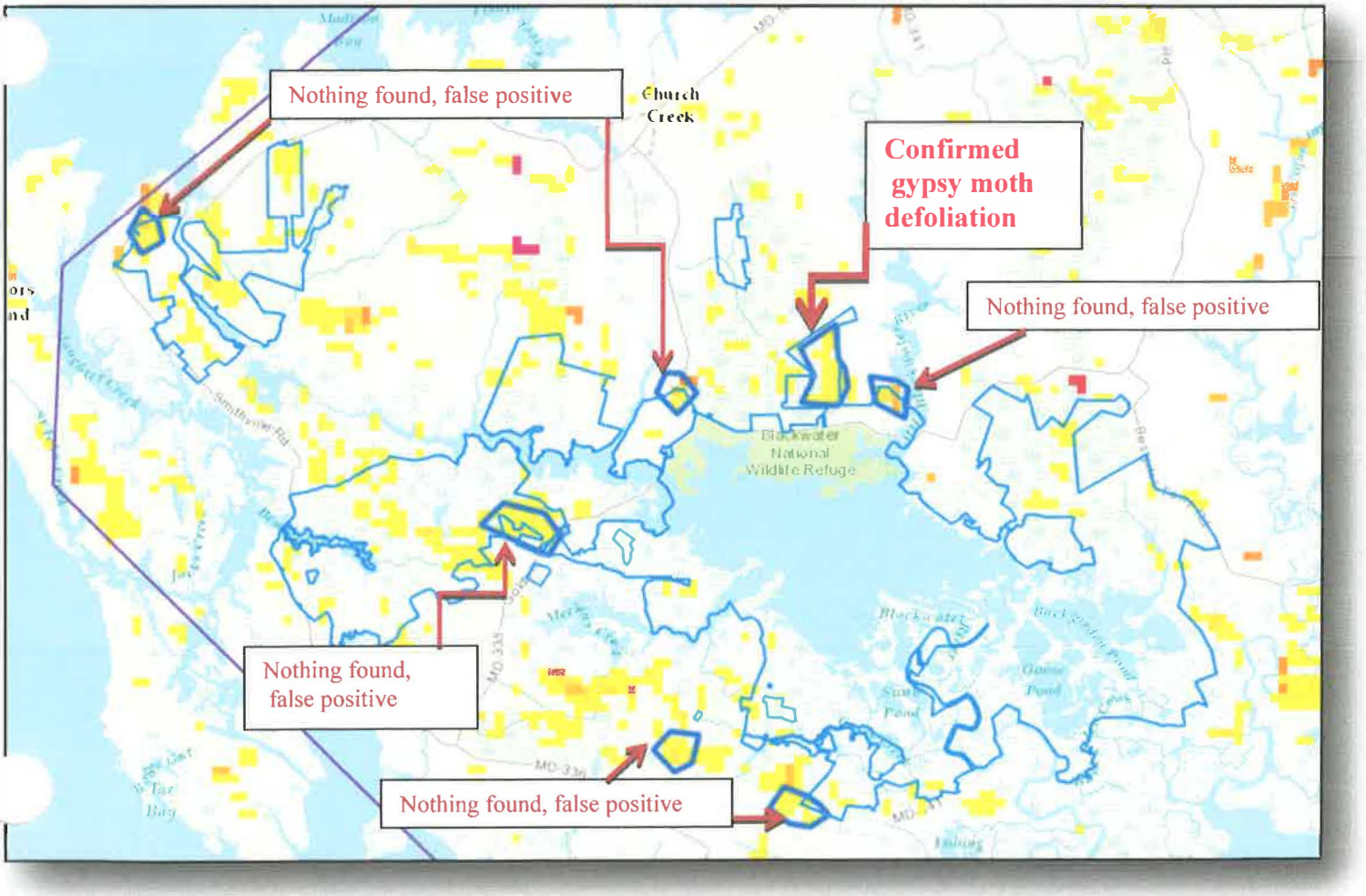


Figure 3. Gypsy moth cadavers on bole of oak tree.

Figure 4. Gypsy moth cadavers on bole of oak tree.

Figure 5. Gypsy moth defoliation in the stand improvement cut in stand 6 at BNWR in June 2014.

Figure 6. Oak trees in stand improvement cut in stand 6 showing different degrees of re-foliation in late August 2014.

Figure 7. 2014 gypsy moth egg mass survey plot locations at Blackwater National Wildlife Refuge (CMNWRC) - Maryland.

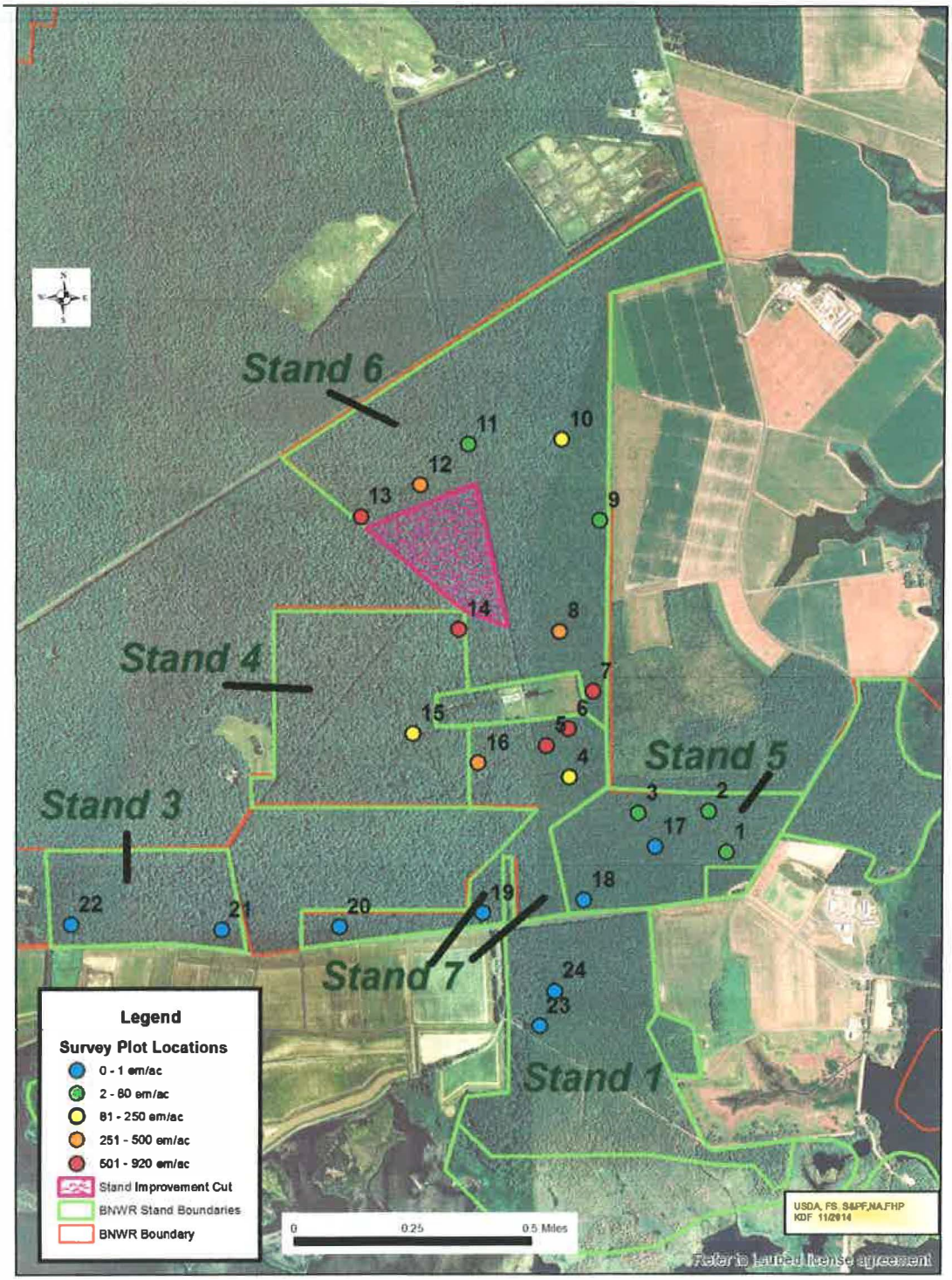
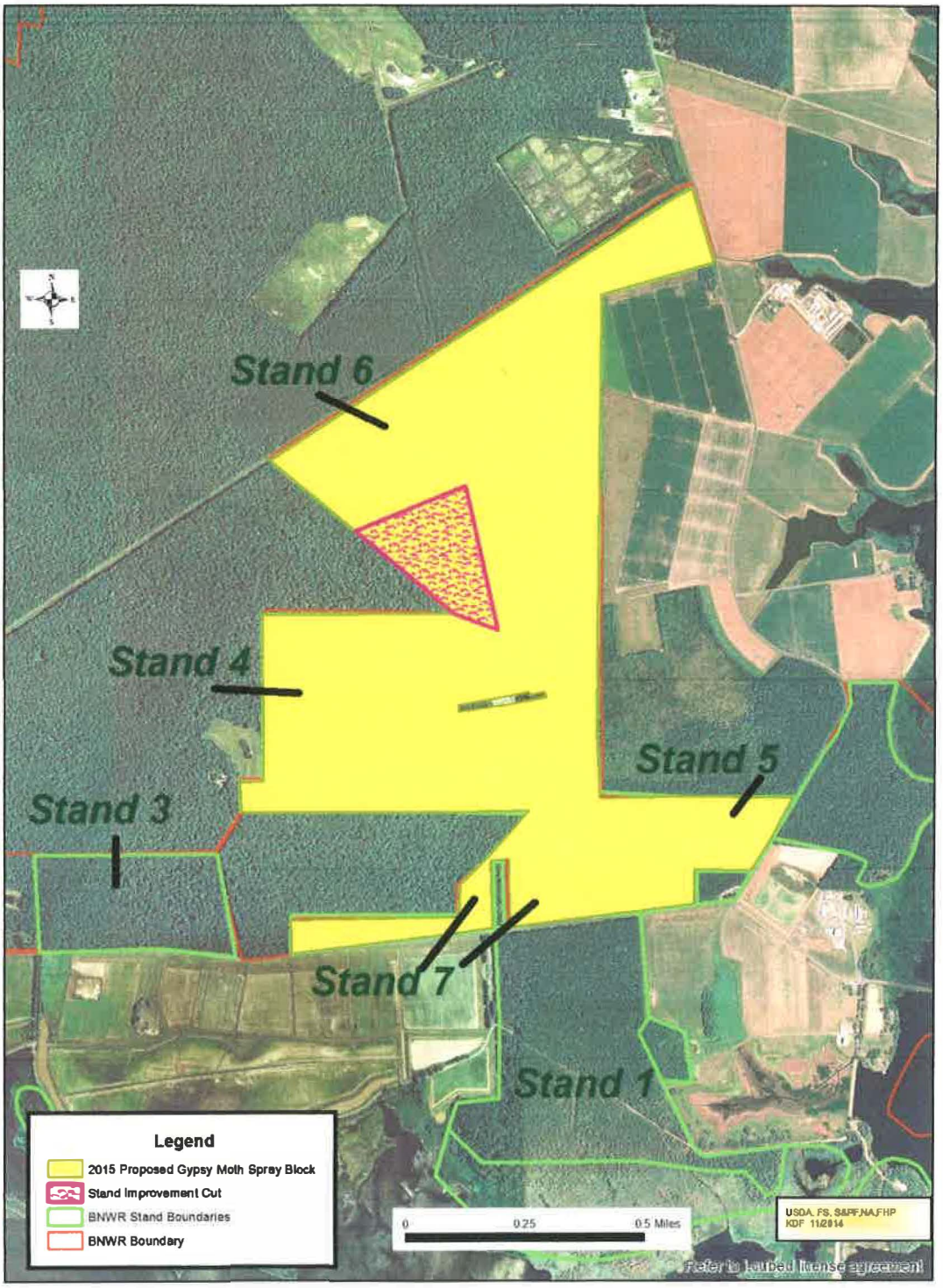
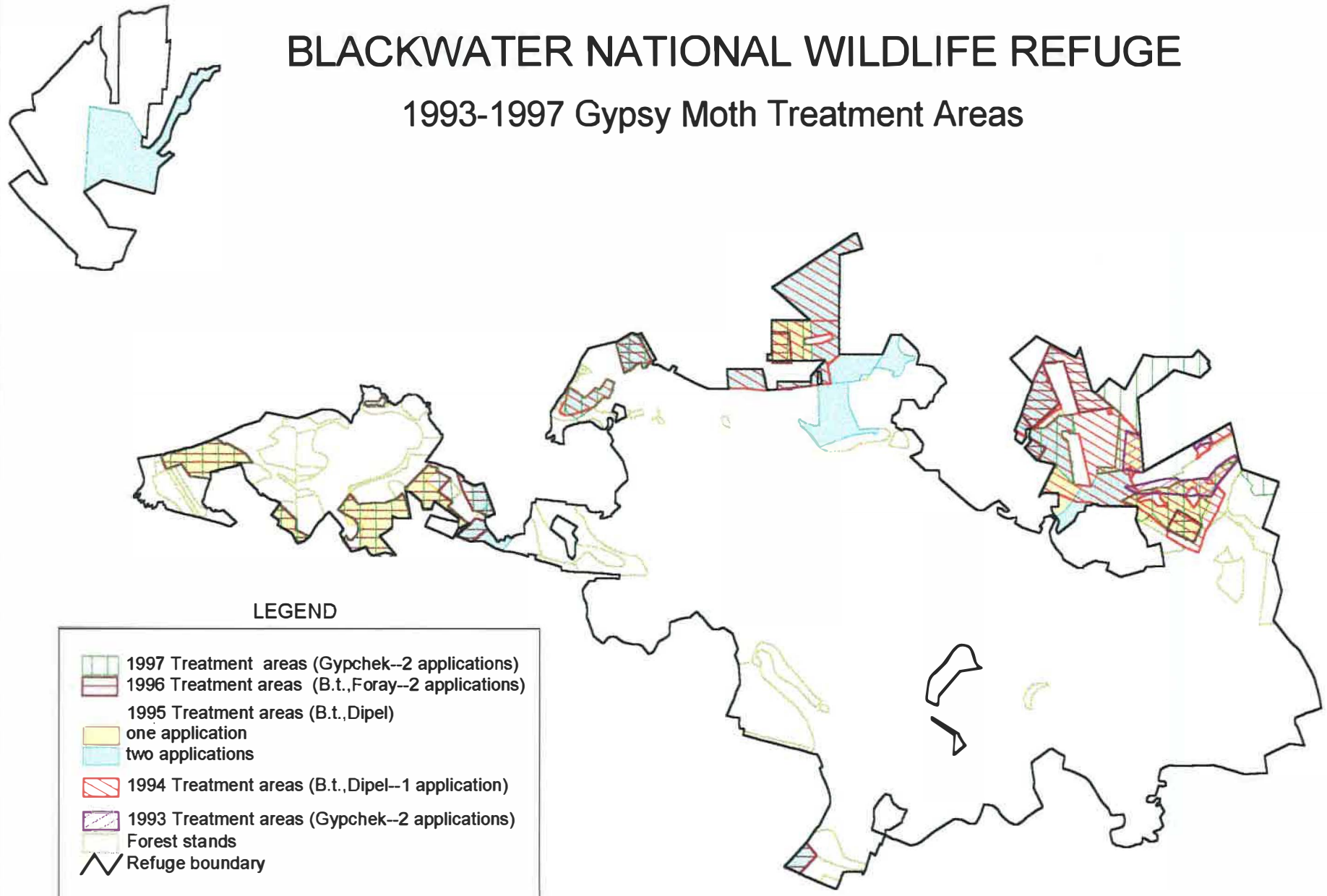


Figure 7. 2015 proposed gypsy moth treament blocks (500 acres) at Blackwater National Wildlife Refuge (CMNWRC) - Maryland.



# BLACKWATER NATIONAL WILDLIFE REFUGE

## 1993-1997 Gypsy Moth Treatment Areas




KDF 1/98

Karen's

**File Code:** 3460
**Date:** December 4, 2014

Susanne Baird
Refuge Manager
USDI Fish and Wildlife Service
Chesapeake Marshlands National Wildlife Refuge Complex
2145 Key Wallace Drive
Cambridge, MD 21613

Dear Ms. Baird:

Enclosed is the 2014 gypsy moth biological evaluation for the Blackwater National Wildlife Refuge portion of the Chesapeake Marshlands National Wildlife Refuge Complex. Current gypsy moth populations are sufficient to cause noticeable defoliation on 500 acres. We are recommending a single aerial application of Gypchek for this area in order to protect the endangered Delmarva fox squirrel habitat from tree defoliation, prevent a reduction in oak mast production, provide nuisance abatement in the Key Wallace Hiking Trail area, and prevent possible oak tree mortality.

We have and will continue to work with Matt Whitbeck, Wildlife Biologist, from Blackwater NWR and we have greatly appreciated his assistance.

If you have any questions concerning this biological evaluation, please contact Karen Felton (304-285-1556) or Dan Twardus (304-285-1545).

Sincerely,

Bob Lueckel

ROBERT LUECKEL
Field Representative

Enclosure

cc: Matt Whitbeck, CMNWRC
Jeff Horan, Forest Ecologist, Regional Office, USDI, F&WS
Bob Tatman, MDA
Noel Schneeberger, AO